

Process Heater Work Group Chair/Co-Chair

ICCR Process Heater Source Work Group

Attached is a table entitled HAPs Selection and Test Methods for Natural Gas and Refinery Gas Fired Process Heaters. The list contains the names of the 189 Hazardous Air Pollutants (HAPs) that have, based on experience, been screened for potential presence in emissions from natural gas and refinery gas fired boilers. This preliminary screening has been performed on the list by the Testing and Monitoring Protocol Work Group (TMPWG). This table is being forwarded to the Process Heater Source Work Group (SWG) for review and comment.

The table includes HAPs that may be present in these emissions. Additionally, a listing of testing methods that have been used and have the potential to quantify the HAPs presence in flue gas emissions are included.

For those HAPs that are not included in the list, a codified reason for their exclusion is provided. Exclusion codes include:

- 1- Compound is not expected to be emitted from source because basic chemical or physical principles do not favor its existence in source exhaust.
- 2 - Existing test data indicate that compound is not emitted in significant quantities from source.

Other exclusion codes are included as appropriate.

It should be noted that this table is general in its first draft and represents the extent of the TMPWG's knowledge and experience with emissions from natural gas and refinery gas fired process heaters. Please review carefully from a standpoint of those HAPs included as well as those HAPs excluded. The subgroup within the TMPWG that is responsible for the development of this table has included a preface that provides the sources of information utilized to develop the table, the rationale for exclusion codes, and the names of the TMPWG contact for the Process Heater SWG.

If we can be of service in any other fashion or if you have any questions concerning in the table, please contact the Lawrence Otwell (e-mail: "lpotwell@gapac.com") the TMPWG member who is monitoring the activities of your SWG or Karl Loos (e-mail: "krloos@shellus.com"), responsible for the Table development.

HAP Selection and Test Methods for Natural Gas and Refinery Gas Fired Process Heaters

Most source testing studies have been carried out to determine criteria pollutant emissions (NO_x, SO₂, etc.) and not HAPs. Analysis of the natural and refinery gas fuels results in the elimination of large categories of HAP compounds such as halogen, nitrogen, sulfur, and metal containing species. Both fuels consist of light hydrocarbon compounds: natural gas is essentially pure methane, while refinery gas is composed of hydrogen and light hydrocarbon vapors, < C-6.

Combustion is a strongly oxidizing process and many compounds are not stable under these conditions. This has been confirmed by the results of extensive testing carried out in California under the sponsorship of the Western States Petroleum Association to develop a combustion device emissions database in accord with the requirements of California State Assembly Bill 2588. Results from this database have been used to select the potential HAPs to be measured for refinery and natural gas fired process heaters.

References

1. "AB2588 Pooled Source Emissions Test Program", The Almaga Corporation Project I6551, The Almaga Corporation Report I6551-4
2. "Pooled Source Testing of Combustion Devices: Database Users Guidance Manual", Energy and Environmental Research Corporation, Irvine CA 92718

HAPS Selection and Test Methods for Source Category				
Source Category:	Natural Gas & Refinery Fuel Gas Fired Process Heaters			
Include in list	CAS No.	Chemical name	If excluded, give reason for exclusion (use codes where appropriate)	If Included, give applicable test method(s)
x	75070	Acetaldehyde		EPA 0011, CARB 430
	60355	Acetamide	1	Method(s)?
	75058	Acetonitrile	1	Method(s)?
	98862	Acetophenone	1	Method(s)?
	53963	2-Acetylaminofluorene	1	Method(s)?
	107028	Acrolein	1	Method(s)?
	79061	Acrylamide	1	Method(s)?
	79107	Acrylic acid	1	Method(s)?
	107131	Acrylonitrile	1	Method(s)?
	107051	Allyl chloride	1	Method(s)?
	92671	4-Aminobiphenyl	1	Method(s)?
	62533	Aniline	1	Method(s)?
	90040	o-Anisidine	1	Method(s)?
	1332214	Asbestos	1	Method(s)?
x	71432	Benzene		EPA 0030, 18; CARB 422
	92875	Benzidine	1	Method(s)?
	98077	Benzotrichloride	1	Method(s)?
	100447	Benzyl chloride	1	Method(s)?
	92524	Biphenyl	1	Method(s)?
	117817	Bis(2-ethylhexyl)phthalate (DEHP)	1	Method(s)?
	542881	Bis(chloromethyl)ether	1	Method(s)?
	75252	Bromoform	1	Method(s)?
	106990	1,3-Butadiene	2	Method(s)?
	156627	Calcium cyanamide	1	Method(s)?
	133062	Captan	1	Method(s)?
	63252	Carbaryl	1	Method(s)?
	75150	Carbon disulfide	1	Method(s)?
	56235	Carbon tetrachloride	1	Method(s)?
	463581	Carbonyl sulfide	1	Method(s)?
	120809	Catechol	1	Method(s)?
	133904	Chloramben	1	Method(s)?
	57749	Chlordane	1	Method(s)?
	7782505	Chlorine	1	Method(s)?
	79118	Chloroacetic acid	1	Method(s)?
	532274	2-Chloroacetophenone	1	Method(s)?
	108907	Chlorobenzene	1	Method(s)?
	510156	Chlorobenzilate	1	Method(s)?
	67663	Chloroform	1	Method(s)?
	107302	Chloromethyl methyl ether	1	Method(s)?
	126998	Chloroprene	1	Method(s)?
	1319773	Cresols/Cresylic acid (isomers and mixture)	2	Method(s)?
	95487	o-Cresol	2	Method(s)?
	108394	m-Cresol	2	Method(s)?
	106445	p-Cresol	2	Method(s)?
	98828	Cumene	2	Method(s)?
	94757	2,4-D, salts and esters	1	Method(s)?
	3547044	DDE	1	Method(s)?
	334883	Diazomethane	1	Method(s)?
	132649	Dibenzofurans	1	Method(s)?

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	96128	1,2-Dibromo3-chloropropane	1	Method(s)?
	84742	Dibutylphthalate	1	Method(s)?
	106467	1,4-Dichlorobenzene(p)	1	Method(s)?
	91941	3,3-Dichlorobenzidene	1	Method(s)?
	111444	Dichloroethyl ether (Bis(2-chloroethyl)ether)	1	Method(s)?
	542756	1,3-Dichloropropene	1	Method(s)?
	62737	Dichlorvos	1	Method(s)?
	111422	Diethanolamine	1	Method(s)?
	121697	N,N-Diethyl aniline (N,N-Dimethylaniline)	1	Method(s)?
	64675	Diethyl sulfate	1	Method(s)?
	119904	3,3-Dimethoxybenzidine	1	Method(s)?
	60117	Dimethyl aminoazobenzene	1	Method(s)?
	119937	3,3--Dimethyl benzidine	1	Method(s)?
	79447	Dimethyl carbamoyl chloride	1	Method(s)?
	68122	Dimethyl formamide	1	Method(s)?
	57147	1,1-Dimethyl hydrazine	1	Method(s)?
	131113	Dimethyl phthalate	1	Method(s)?
	77781	Dimethyl sulfate	1	Method(s)?
	534521	4,6-Dinitroo-cresol, and salts	1	Method(s)?
	51285	2,4-Dinitrophenol	1	Method(s)?
	121142	2,4-Dinitrotoluene	1	Method(s)?
	123911	1,4-Dioxane (1,4-Diethyleneoxide)	2	Method(s)?
	122667	1,2-Diphenylhydrazine	1	Method(s)?
	106898	Epichlorohydrin (l-Chloro-2,3-epoxypropane)	1	Method(s)?
	106887	1,2-Epoxybutane	1	Method(s)?
	140885	Ethyl acrylate	1	Method(s)?
x	100414	Ethyl benzene		EPA 0030, 18; CARB 422
	51796	Ethyl carbamate (Urethane)	1	Method(s)?
	75003	Ethyl chloride (Chloroethane)	1	Method(s)?
	106934	Ethylene dibromide (Dibromoethane)	1	Method(s)?
	107062	Ethylene dichloride (1,2-Dichloroethane)	1	Method(s)?
	107211	Ethylene glycol	1	Method(s)?
	151564	Ethylene imine (Aziridine)	1	Method(s)?
	75218	Ethylene oxide	1	Method(s)?
	96457	Ethylene thiourea	1	Method(s)?
	75343	Ethylidene dichloride (1,1-Dichloroethane)	1	Method(s)?
x	50000	Formaldehyde		EPA 0011, CARB 430
	76448	Heptachlor	1	Method(s)?
	118741	Hexachlorobenzene	1	Method(s)?
	87683	Hexachlorobutadiene	1	Method(s)?
	77474	Hexachlorocyclopentadiene	1	Method(s)?
	67721	Hexachloroethane	1	Method(s)?
	822060	Hexamethylene-1,6-diisocyanate	1	Method(s)?
	680319	Hexamethylphosphoramide	1	Method(s)?
	110543	Hexane	1	
	302012	Hydrazine	1	Method(s)?
	7647010	Hydrochloric acid	1	Method(s)?
	7664393	Hydrogen fluoride (Hydrofluoric acid)	1	Method(s)?
	7783064	Hydrogen sulfide	1	Method(s)?

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Include in list	CAS No.	Chemical name	If excluded, give reason for exclusion (use codes where appropriate)	If Included, give applicable test method(s)
	123319	Hydroquinone	1	Method(s)?
	78591	Isophorone	1	Method(s)?
	58899	Lindane (all isomers)	1	Method(s)?
	108316	Maleic anhydride	1	Method(s)?
	67561	Methanol	1	Method(s)?
	72435	Methoxychlor	1	Method(s)?
	74839	Methyl bromide (Bromomethane)	1	Method(s)?
	74873	Methyl chloride (Chloromethane)	1	Method(s)?
	71556	Methyl chloroform (1,1,1-Trichloroethane)	1	Method(s)?
	78933	Methyl ethyl ketone (2-Butanone)	2	Method(s)?
	60344	Methyl hydrazine	1	Method(s)?
	74884	Methyl iodide (Iodomethane)	1	Method(s)?
	108101	Methyl isobutyl ketone (Hexone)	1	Method(s)?
	624839	Methyl isocyanate	1	Method(s)?
	80626	Methyl methacrylate	1	Method(s)?
	1634044	Methyl tert butyl ether	1	Method(s)?
	101144	4,4-Methylene bis(2-chloroaniline)	1	Method(s)?
	75092	Methylene chloride (Dichloromethane)	1	Method(s)?
	101688	Methylene diphenyl diisocyanate (MDI)	1	Method(s)?
	101779	4,4--Methylenedianiline	1	Method(s)?
x	91203	Naphthalene		EPA 0010; CARB 429
	98953	Nitrobenzene	1	Method(s)?
	92933	4-Nitrobiphenyl	1	Method(s)?
	100027	4-Nitrophenol	1	Method(s)?
	79469	2-Nitropropane	1	Method(s)?
	684935	N-Nitroso-Nmethylurea	1	Method(s)?
	62759	N-Nitrosodimethylamine	1	Method(s)?
	59892	N-Nitrosomorpholine	1	Method(s)?
	56382	Parathion	1	Method(s)?
	82688	Pentachloronitrobenzene (Quintobenzene)	1	Method(s)?
	87865	Pentachlorophenol	1	Method(s)?
x	108952	Phenol		EPA 0010; CARB 429(m)
	106503	p-Phenylenediamine	1	Method(s)?
	75445	Phosgene	1	Method(s)?
	7803512	Phosphine	1	Method(s)?
	7723140	Phosphorus	1	Method(s)?
	85449	Phthalic anhydride	1	Method(s)?
	1336363	Polychlorinated biphenyls (Aroclors)	1	Method(s)?
	1120714	1,3-Propane sultone	1	Method(s)?
	57578	beta-Propiolactone	1	Method(s)?
	123386	Propionaldehyde	1	Method(s)?
	114261	Propoxur (Baygon)	1	Method(s)?
	78875	Propylene dichloride (1,2-Dichloropropane)	1	Method(s)?
	75569	Propylene oxide	1	Method(s)?
	75558	1,2-Propylenimine (2-Methyl aziridine)	1	Method(s)?
	91225	Quinoline	1	Method(s)?
	106514	Quinone	1	Method(s)?
	100425	Styrene	1	Method(s)?
	96093	Styrene oxide	1	Method(s)?

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	1746016	2,3,7,8-Tetrachlorodibenzo-p-dioxin	1	Method(s)?
	79345	1,1,2,2-Tetrachloroethane	1	Method(s)?
	127184	Tetrachloroethylene (Perchloroethylene)	1	Method(s)?
	7550450	Titanium tetrachloride	1	Method(s)?
x	108883	Toluene		EPA 0030, 18; CARB 422
	95807	2,4-Toluene diamine	1	Method(s)?
	584849	2,4-Toluene diisocyanate	1	Method(s)?
	95534	o-Toluidine	1	Method(s)?
	8001352	Toxaphene (chlorinated camphene)	1	Method(s)?
	120821	1,2,4-Trichlorobenzene	1	Method(s)?
	79005	1,1,2-Trichloroethane	1	Method(s)?
	79016	Trichloroethylene	1	Method(s)?
	95954	2,4,5-Trichlorophenol	1	Method(s)?
	88062	2,4,6-Trichlorophenol	1	Method(s)?
	121448	Triethylamine	1	Method(s)?
	1582098	Trifluralin	1	Method(s)?
	540841	2,2,4-Trimethylpentane	2	Method(s)?
	108054	Vinyl acetate	1	Method(s)?
	593602	Vinyl bromide	1	Method(s)?
	75014	Vinyl chloride	1	Method(s)?
	75354	Vinylidene chloride (1,1-Dichloroethylene)	1	Method(s)?
x	1330207	Xylenes (isomers and mixture)		EPA 0030, 18; CARB 422
x	95476	o-Xylenes		EPA 0030, 18; CARB 422
x	108383	m-Xylenes		EPA 0030, 18; CARB 422
x	106423	p-Xylenes		EPA 0030, 18; CARB 422
	N/A	Antimony Compounds	1	Method(s)?
	N/A	Arsenic Compounds (inorganic including arsine)	1	Method(s)?
	N/A	Beryllium Compounds	1	Method(s)?
	N/A	Cadmium Compounds	1	Method(s)?
	N/A	Chromium Compounds	1	Method(s)?
	N/A	Cobalt Compounds	1	Method(s)?
	N/A	Coke Oven Emissions	NA	Method(s)?
	N/A	Cyanide Compounds *1	1	Method(s)?
	N/A	Glycol ethers *2	1	Method(s)?
	N/A	Lead Compounds	1	Method(s)?
	N/A	Manganese Compounds	1	Method(s)?
	N/A	Mercury Compounds	1	Method(s)?
	N/A	Fine mineral fibers *3	1	Method(s)?
	N/A	Nickel Compounds	1	Method(s)?
x	N/A	Polycyclic Organic Matter *4		EPA 0010; CARB 429
	N/A	Radionuclides (including radon) *5	1	Method(s)?
	N/A	Selenium Compounds	1	Method(s)?